Philip Chizek
Global Marketing & Sales
Fuel Cells & e-drive programs

S

T Technologies

Environmental Vision

“ In today’s world, solving environmental problems is an investment, not an expense.”

William Clay Ford, Jr.
Chairman and CEO,
Ford Motor Company

TH!NK Technologies
Role within Ford's Trustmark

Global Center of Excellence for design & development of electric drive vehicle propulsion technology

- Develop Fuel Cell programs for all Trustmark Brands
- Electric Drivetrain for Hybrids
- Support *TH!NK* Mobility battery driven products

THINK

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www.think-technologies.com

Focus FCV
Hydrogen Fuel Cell

Focus FC5
Methanol Fuel Cell

P2000
Hydrogen Fuel Cell

USPS EV

Ranger EV

www.thinkmobility.com

THINK city
Electric Vehicle

THINK neighbor
Low Speed Vehicle

THINK bike traveler
Folding Electric Bike

THINK bike fun
Electric Bike

Ford Motor Company

Fuel Cell

An energy conversion device that electrochemically converts chemical energy into electrical energy.

Why Investigate Fuel Cells?

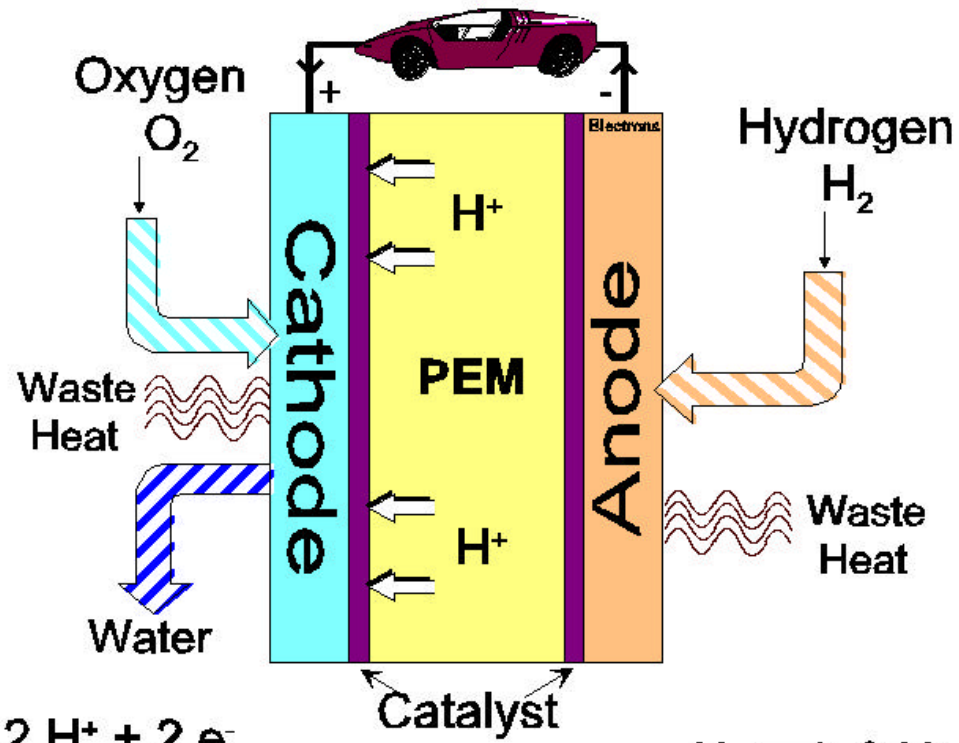
Fuel cells offer substantial benefits toward improving transportation's impact on health and environment.

Fuel Cell Vehicle Potential

- **Zero emission vehicle**
- **2 - 3 times the fuel economy of conventional internal combustion engines (ICE)**
- **Comparable performance compared to ICE**
- **Sustainable Transportation**
- **Less dependence on imported oil**

*** using hydrogen fuel**

Operation of a PEM Fuel Cell

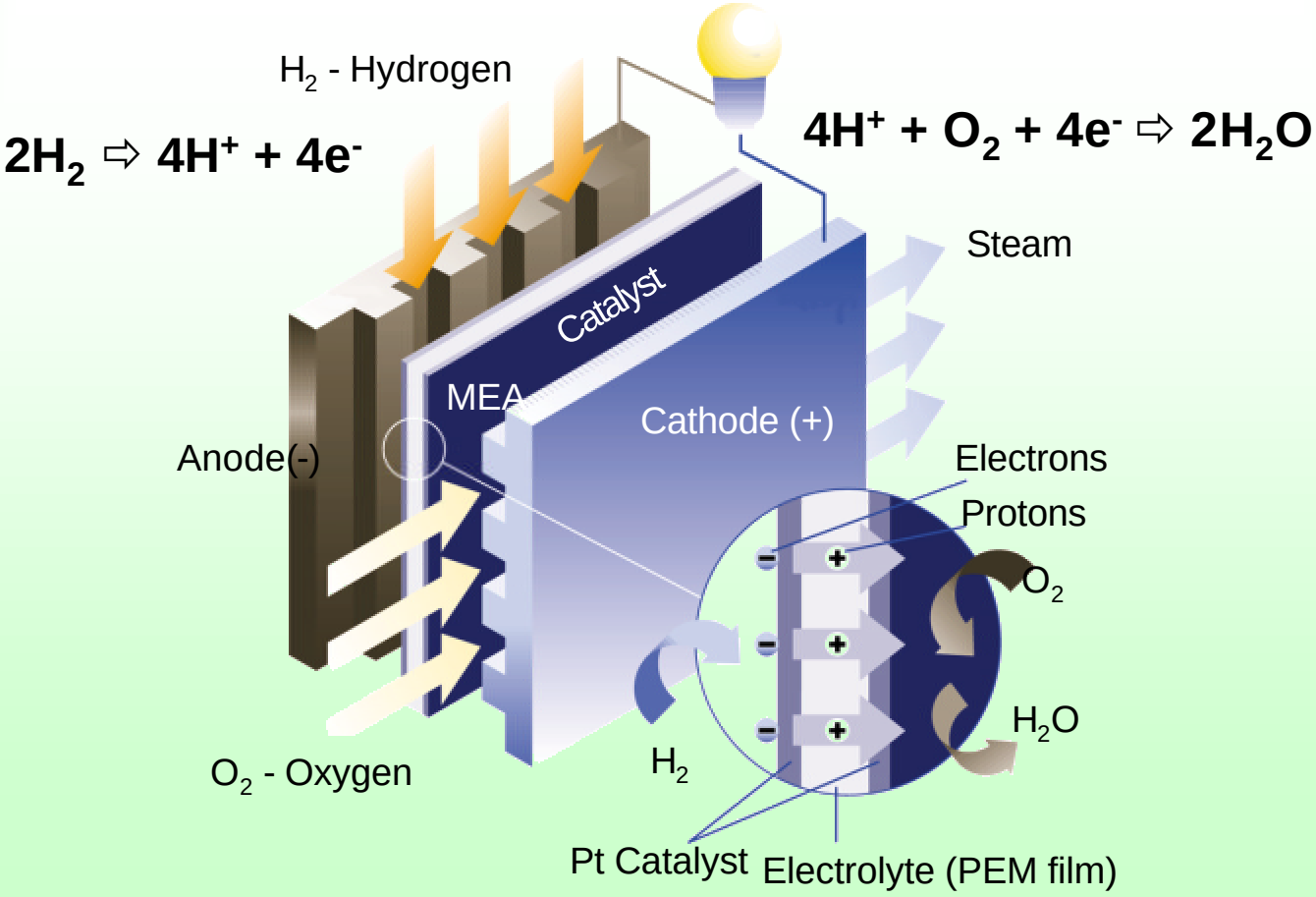


$1/2\ O_2 + 2\ H^+ + 2\ e^- \rightleftharpoons H_2O$

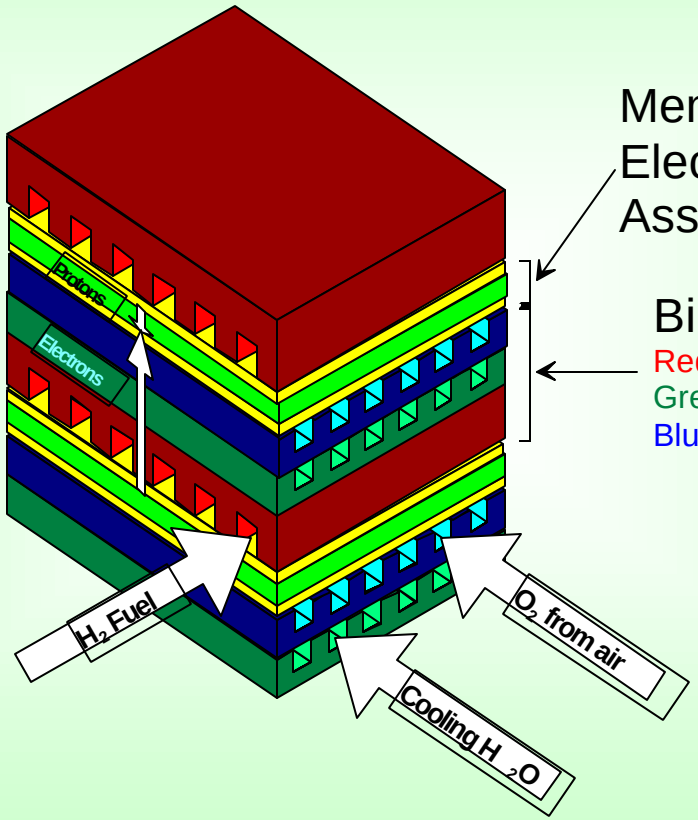
$H_2 \rightleftharpoons 2\ H^+ + 2\ e^-$

$H_2 + 1/2\ O_2 \rightleftharpoons H_2O$

PEM Fuel Cell Operation



Typical PEM Fuel Cell Construction

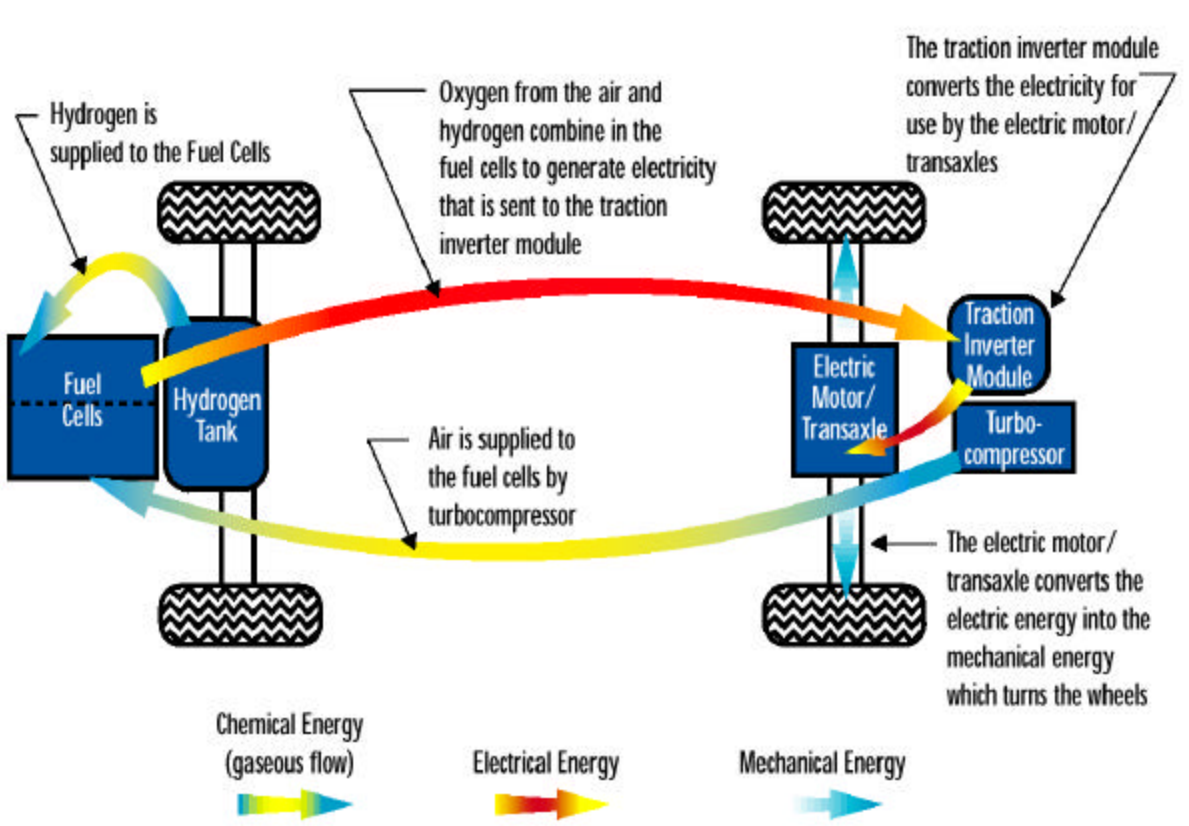


Membrane Electrode Assembly

Bipolar Plates
Red - Anode Side
Green - Cooling Plate
Blue - Cathode Side

Ian D. Sims, July 1993 - revised, JAA 02/18/99

Fuel Cell Powered Vehicle



Fuel Cell Demo Vehicles

1998

P2000

FCEV

Gaseous Hydrogen

2000

California Demo

Ford Focus

Gaseous Hydrogen

2001

Japan Demo

Mazda Premacy

Methanol

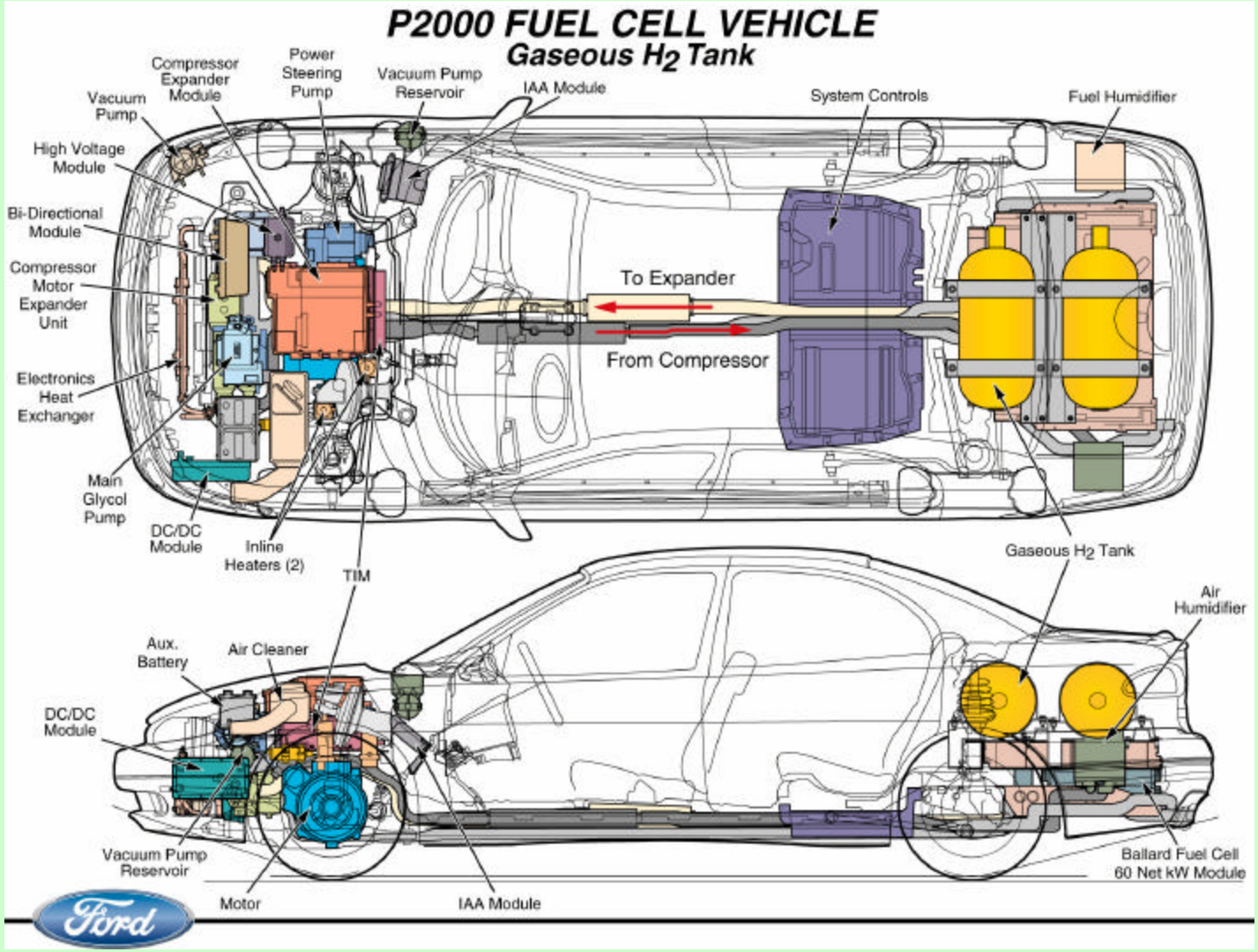
P2000 FCEV

Features

- Compressed hydrogen
- PEM fuel cell array
- Taurus-size interior
- Lightweight aluminum body and structure
- Driveability of a conventional vehicle

P2000 FCV Performance Data

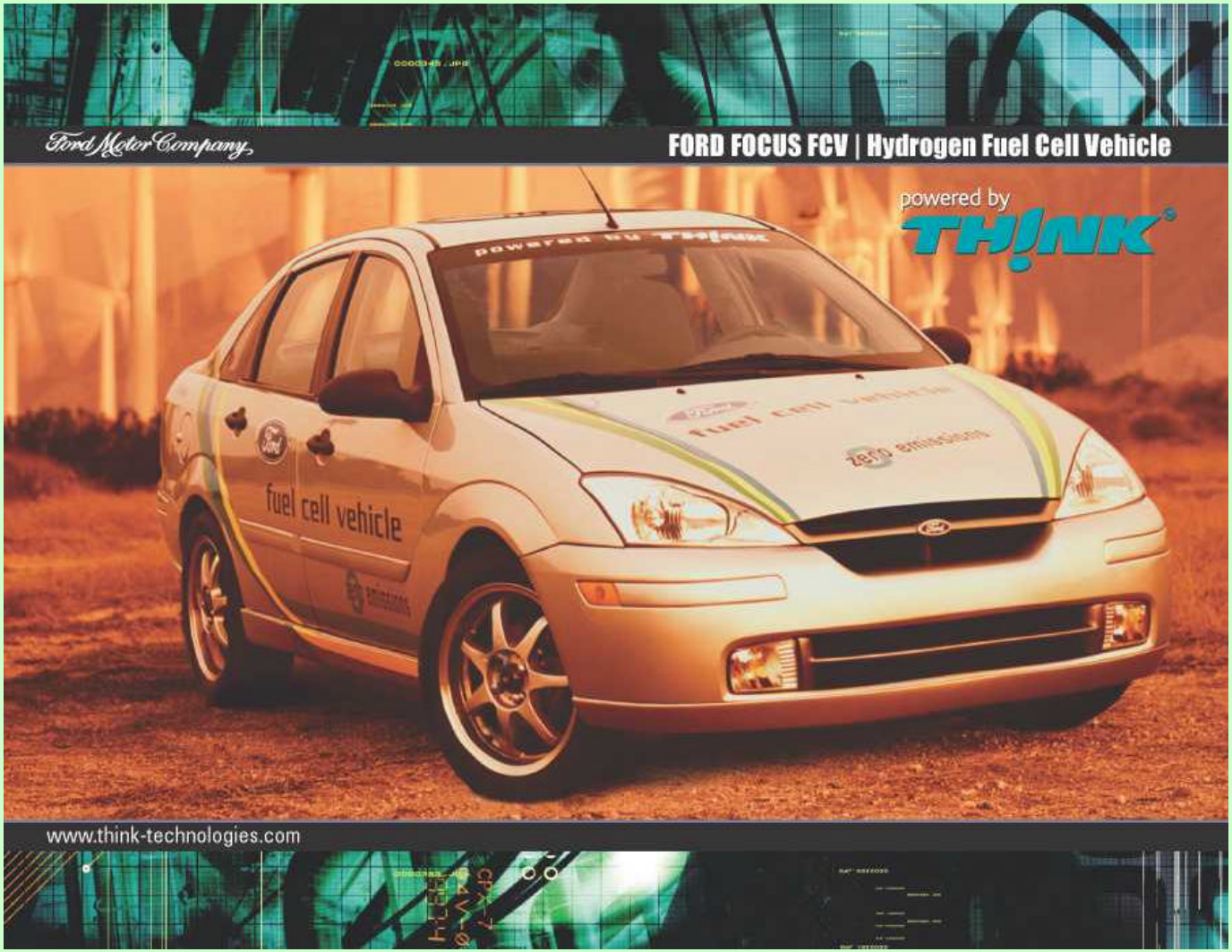
Driving Range (EPA 75)	**over 100 miles**
Fuel Efficiency (EPA75 / Highway)	**58 / 81 miles per gallon of equivalent gasoline**
Top Speed	**over 80 mph**
Acceleration (0 - 30 / 0 - 60 mph)	**4.2 / 12.3 sec.**


P2000 FUEL CELL VEHICLE
Gaseous H_2 Tank
Compressor Expander Module
Power Steering Pump
Vacuum Pump Reservoir
IAA Module
Vacuum Pump
System Controls
Fuel Humidifier
High Voltage Module
Bi-Directional Module
Compressor Motor Expander Unit
To Expander
From Compressor
Electronics Heat Exchanger
Main Glycol Pump
DC/DC Module
Inline Heaters (2)
TIM
Gaseous H_2 Tank
Air Humidifier
Aux. Battery
Air Cleaner
DC/DC Module
Vacuum Pump Reservoir
Motor
IAA Module
Ballard Fuel Cell 60 Net kW Module
Ford


MAKE FUEL CELL
DATE 10-22-98
ENGINEER RON KLINGER
TOM MARTIN


Powered By
Fuel Cell
Ford
8/14/1999

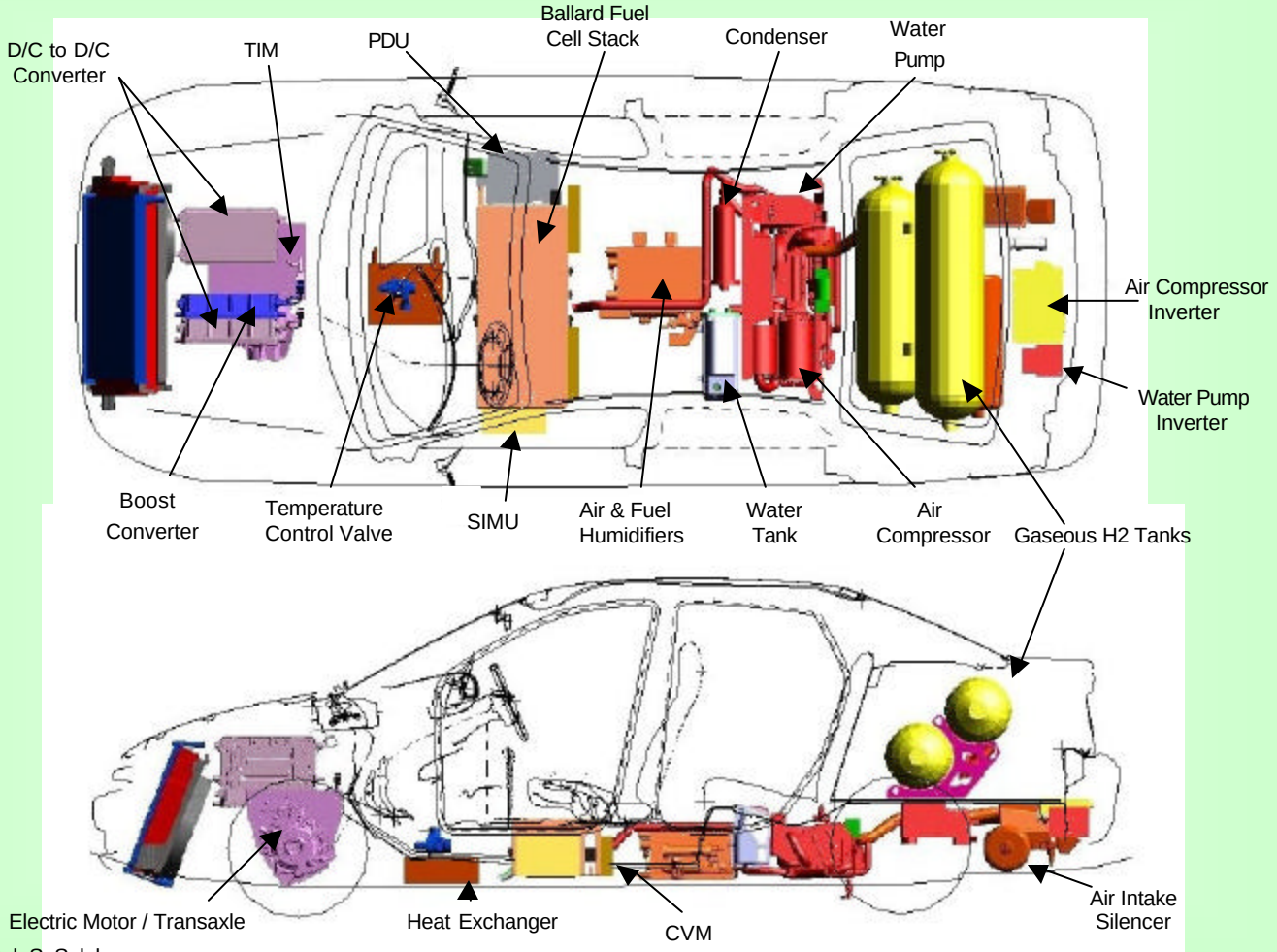

DynaCell - Advanced Fuel Storage Systems
PROTOTYPE
HYDROGEN FUEL ONLY
DO NOT USE AFTER 11/2003
8/14/1999


Ford Motor Company
FORD FOCUS FCV | Hydrogen Fuel Cell Vehicle
powered by
THINK
fuel cell vehicle
zero emissions
www.think-technologies.com

Focus FCV Performance Data

Driving Range (EPA 75)	**over 100 miles**
Fuel Efficiency (EPA75 / Highway)	**58 / 81 miles per gallon of equivalent gasoline**
Top Speed	**over 80 mph**
Acceleration (0 - 30 / 0 - 60 mph)	**4.2 / 14.3 sec.**

Ford's Focus FCV (Fuel Cell Vehicle)



Created by Mark S. Sulek
Focus FCV Schematic.ppt

Date issued 1/19/2001
Date Revised 1/19/2001

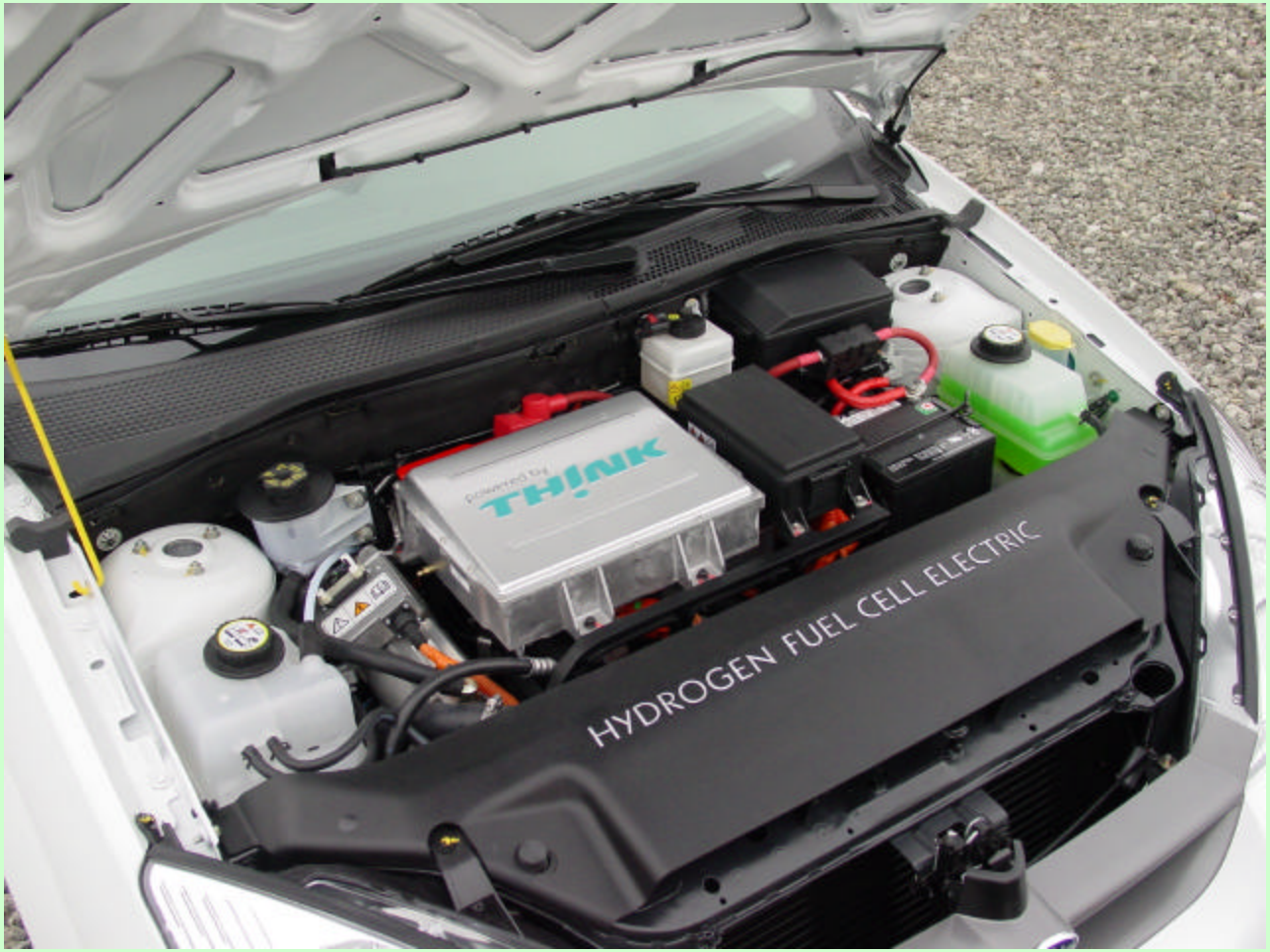

Ford
fuel cell vehicle

2002 Ford Focus, Hybrid Fuel Cell

Focus Hybrid FCV Performance Data

Driving Range (EPA 75)	**160 to 200 miles**
Fuel Efficiency (EPA75 / Highway)	**58 / 81 miles per gallon of equivalent gasoline**
Top Speed	**Over 80 mph**
Acceleration (0 - 30 / 0 - 60 mph)	**3.0 to 4.2 / 10 to 14.0 sec.**


powered by THINK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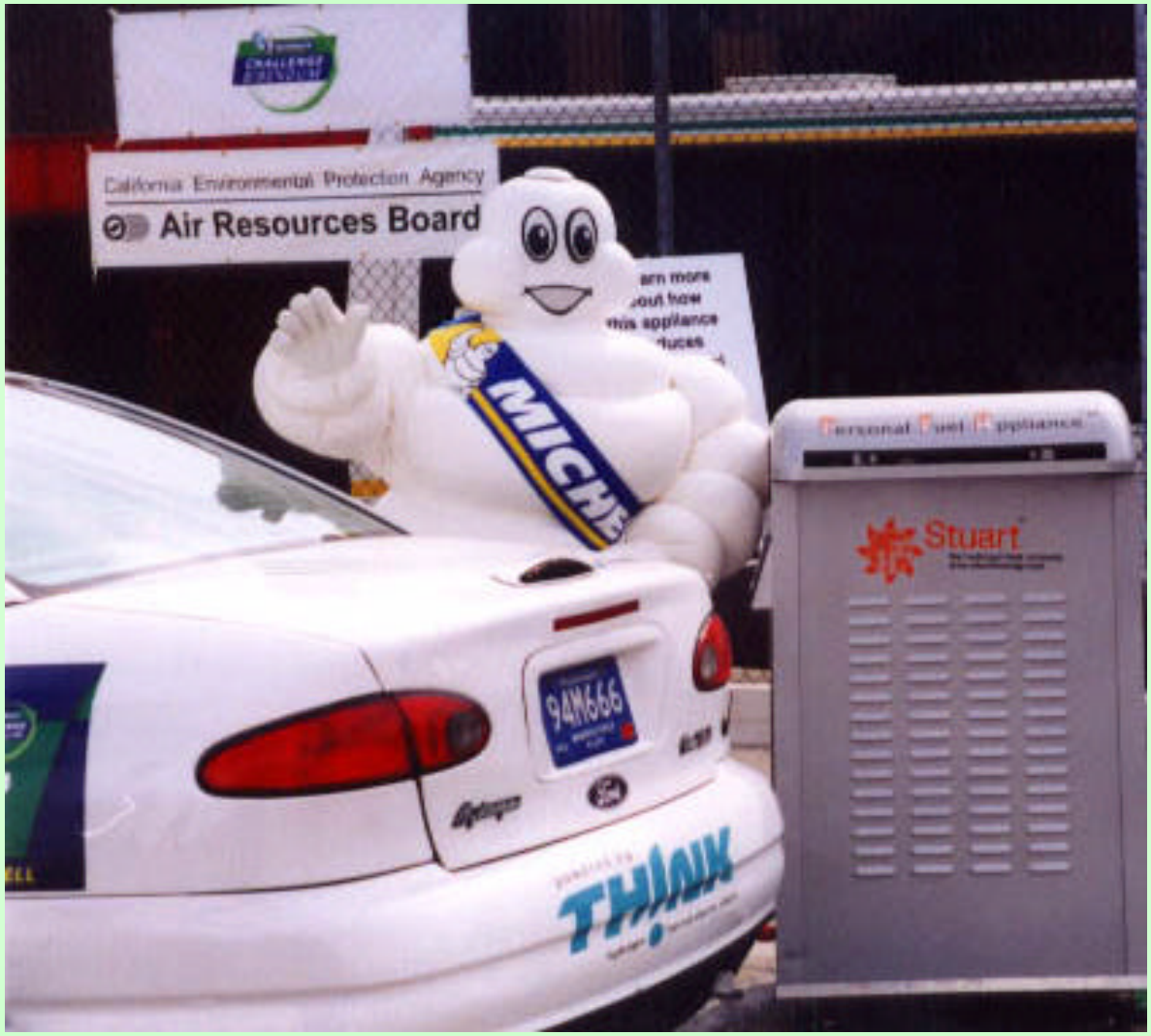
THINK
HYDROGEN FUEL CELL ELECTRIC

Refueling


EMISSIONS


California Environmental Protection Agency
Air Resources Board
MICH
94M666
Stuart
THINK

Challenges

Commercialization Challenges

- Affordable price
- Traffic compatible performance
- 300+ miles range
- Convenient refueling
- Practical payload
- Good ride, handling and low NVH
- Reliable and safe operation
- Rapid start-up

Commercialization Challenges

Pros

- High fuel efficiency
- Zero emissions
- High tech image
- Fuel flexibility
- Possible use of renewable energy

Cons

- Cost premium
- Hydrogen safety perception
- Limited refueling
- Unfamiliar technology
- Codes/Standards
- ICE progress

The Cost Challenge

The Consumer will not pay a premium for Fuel Cell technology

- Fuel Cell Vehicles must be cost competitive with advanced ICEs and hybrids

Fuel Cell Alliance
Ford/DaimlerChrysler/Ballard

- Develop commercially viable electric powertrain technology for fuel cell and other applications
- Supply world class electric powertrain systems to automotive customers worldwide
- Support high volume, non-automotive markets to expand volume and accelerate progress to commercial viability

Bringing together automakers, energy providers, technology companies and government agencies

Partnership Members

Technology Partners

- Ballard Power Systems
- International Fuel Cells
- Daimler Chrysler
- Ford Motor Company
- Honda
- Hyundai
- Nissan
- Volkswagen
- General Motors
- Toyota

Fuel Partners

- BP
- Shell Hydrogen
- Texaco
- ExxonMobil

Government Partners

- California Air Resources Board
- California Energy Commission
- South Coast Air Quality Management District
- U.S. Department of Energy
- U.S. Department of Transportation

Associate Partners

- Air Products and Chemicals, Inc.
- Praxair
- Methanex
- Sunline Transit Agency
- AC Transit Agency
- Hydrogen Burner Technology
- Proton Energy Systems
- Stuart Energy
- Pacific Gas and Electric

Summary and Conclusions

- **PEM fuel cells have enormous potential**
  - **Zero emission vehicle**
  - **Fuel efficient**
  - **Competitive with ICE performance**

- **Our Goal: Transform this potential into a consumer acceptable products.**

VIP Event Photos

WHQ - Bill Ford, Jr. with Fuel Cell Team

Educating President Bush about Ford's Fuel Cell Efforts


CONTINENTAL


Ford
fuel cell vehicle
zero emissions

P2000 with Canada's Prime Minister Chretien

To Learn More

www.think-technologies.com